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MICROGRAVITY ACCELERATION MEASUREMENT AND ENVIRONMENT CHARACTERIZATION SCIENCE (17-IML-1)

Science

The Space Acceleration Measurement System (SAMS) is a general purpose instrumentation system designed to measure the accelerations onboard the Shuttle Orbiter and Shuttle/Spacelab vehicles (see Figure 1). These measurements are used to support microgravity experiments and investigations into the microgravity environment of the vehicle. Acceleration measurements can be made at locations remote from the SAMS main instrumentation unit by the use of up to three remote triaxial sensor heads. The SAMS was developed by NASA's Lewis Research Center (LeRC) in support of NASA's microgravity science programs.

The prime objective for SAMS on the IML-1 mission will be to measure the accelerations experienced by the Fluid Experiment System (FES). The SAMS acceleration measurements for FES will be complemented by low-level, low-frequency acceleration measurements made by the Orbital Acceleration Research Experiment (OARE) installed on the shuttle. Secondary objectives for SAMS will be to measure accelerations at several specific locations to enable the acceleration transfer function of the Spacelab module to be analyzed. This analysis effort will be in conjunction with similar measurements analyses on other Spacelab missions.

In the past, numerous acceleration measurement systems have flown on various space missions. These systems were tailored to measure accelerations for a narrow set of requirements and were limited in bandwidth, dynamic range, and recording capability. In addition, these systems were mission peculiar and not easily modified for other applications. The result has been an inability to accurately assess the expected microgravity environment prior to a mission for a particular experiment and/or location.

SAMS configurations are under development for the Orbiter Middeck locker area, Spacelab SMIDEX rack and Spacelab center aisle and under development for the Orbiter cargo bay, enabling microgravity measurements at nearly any desired payload location.

SAMS units are currently mainfested on the SLS-1, IML-1, SL- J, USML-1, USMP-1 and IML-2 missions. There will be eight flight units fabricated to support the expected flight rate of microgravity science missions (e.g., IML-3, USML-2, USMP-2).

Instrument

A SAMS unit consists of a main unit (shown in Figure 2 with one triaxial sensor head) and up to three remote triaxial sensor heads. The main unit is comprised of the crew interface, optical disk data storage devices, and control and processing electronics. The remote triaxial sensor heads are comprised of three single axis acceleration sensors, preamplifiers and filters. Each head is connected to the main unit by an umbilical cable which has a maximum length of 20 feet.

The low-pass bandwidth for a triaxial sensor head is independent of the bandwidth of the other two heads and is chosen to match the requirements of the supported experiment. Standard choices for the low-pass bandwidth of a head are 0 to 2.5, 5, 10, 25, 50, and 100 Hz.

The standard SAMS triaxial sensor head employs the Sundstrant QA-2000 sensors, having a resolution of 1 μg. Two triaxial sensor heads utilizing Bell XI-79 sensors are also available having a resolution of 0.01 μg. The SAMS uses simultaneous sample and hold circuits to maintain phase coherence in the three axis measurements of a given triaxial sensor head. Similarly, the outputs of the three sensors of a given triaxial sensor head are digitized by the same 16 bit analog to digital converter. The signal processing for each triaxial sensor head has filtering characteristics matched to the data sampling rate for that triaxial sensor head. The preamplifier has four decade gain ranges and the capability for an electronic calibration mode.

The triaxial sensor head digitized data is formatted and transferred to optical disk. The optical disk drive enables crew-tended disk changes which allow nearly unlimited data storage during a mission. With 200 megabytes of storage per optical disk side, typical times between disk change operations are from hours to days, depending on the triaxial sensor head sampling rates.

To support the FES on IML-1, one SAMS head will be mounted on the FES optical bench in rack #10. This triaxial sensor head will utilize Sundstrang model QA1000 sensors and will be set for 100 hertz and 500 samples per second. This will result in measuring the acceleration environment experienced by the equipment mounted on the FES optical bench.

To measure the low-frequency accelerations experienced by the FES, the second head will be mounted toward the bottom of rack #10 and will be set for 2.5 hertz and 12.5 samples per second. This triaxial sensor head will utilize more sensitive Bell model XI-79 sensors and will be set for 2.5 hertz and 12.5 samples per second. Acceleration data (below 1 hertz) from the OARE will also be utilized to complement these low-frequency SAMS measurements. The OARE utilizes a MESA type of sensor which is particularly good (although expensive) for low-frequency, low magnitude measurements.

The third SAMS head will be mounted below the Spacelab module floor beneath the Microgravity Vestibular Investigations (MVI) rotating chair. This triaxial sensor head will utilize Sundstrand model QA2000 sensors and will be set for 100 hertz and 500 samples per second. This will characterize the MVI rotating chair as an acceleration source and will, in conjunction with the other two heads, allow characterization of the Spacelab module acceleration transfer function to be studied.

Data Processing and Analysis

Post mission processing of data by the SAMS project will be limited to data extraction, compensation, identification, format conversion, archival and dissemination. The processed data will be provided to the principal investigators involved with the particular mission and other interested organizations as required.

In conjunction with the SAMS project, researchers at The University of Alabama at Huntsville and The Charles Stark Draper Laboratories have initiated work to characterize the microgravity environment using the data obtained from the Spacelab-3 mission and the IML-1 mission.

The archival of SAMS data, combined with acceleration data from other sources (e.g., OARE, experiment accelerometers) will make possible the assessment of the microgravity environment of the Shuttle and Spacelab vehicles. This is an important step towards accommodating science experiments on these vehicles.

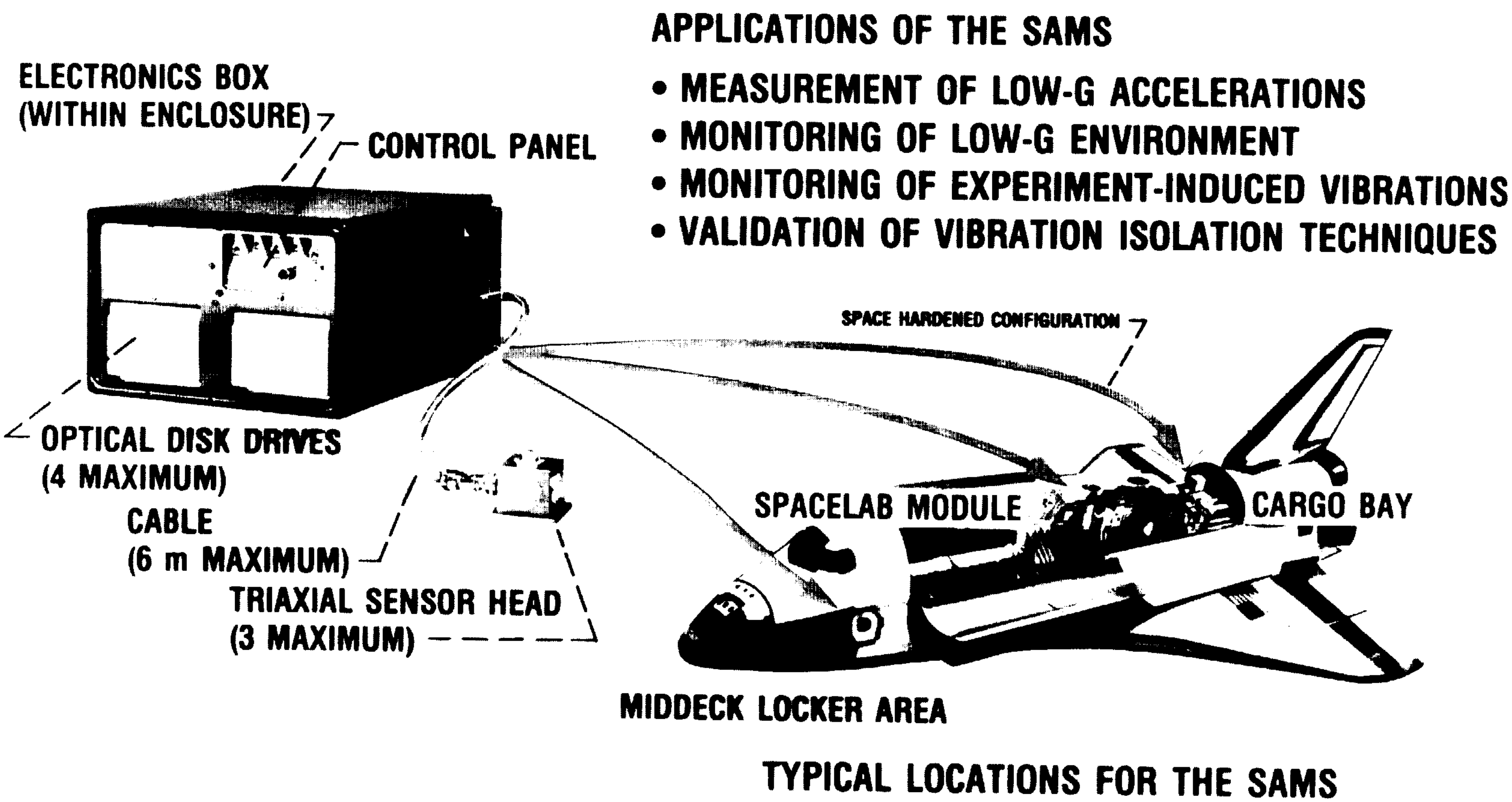

Figure 1. Space acceleration measurement system (SAMS).

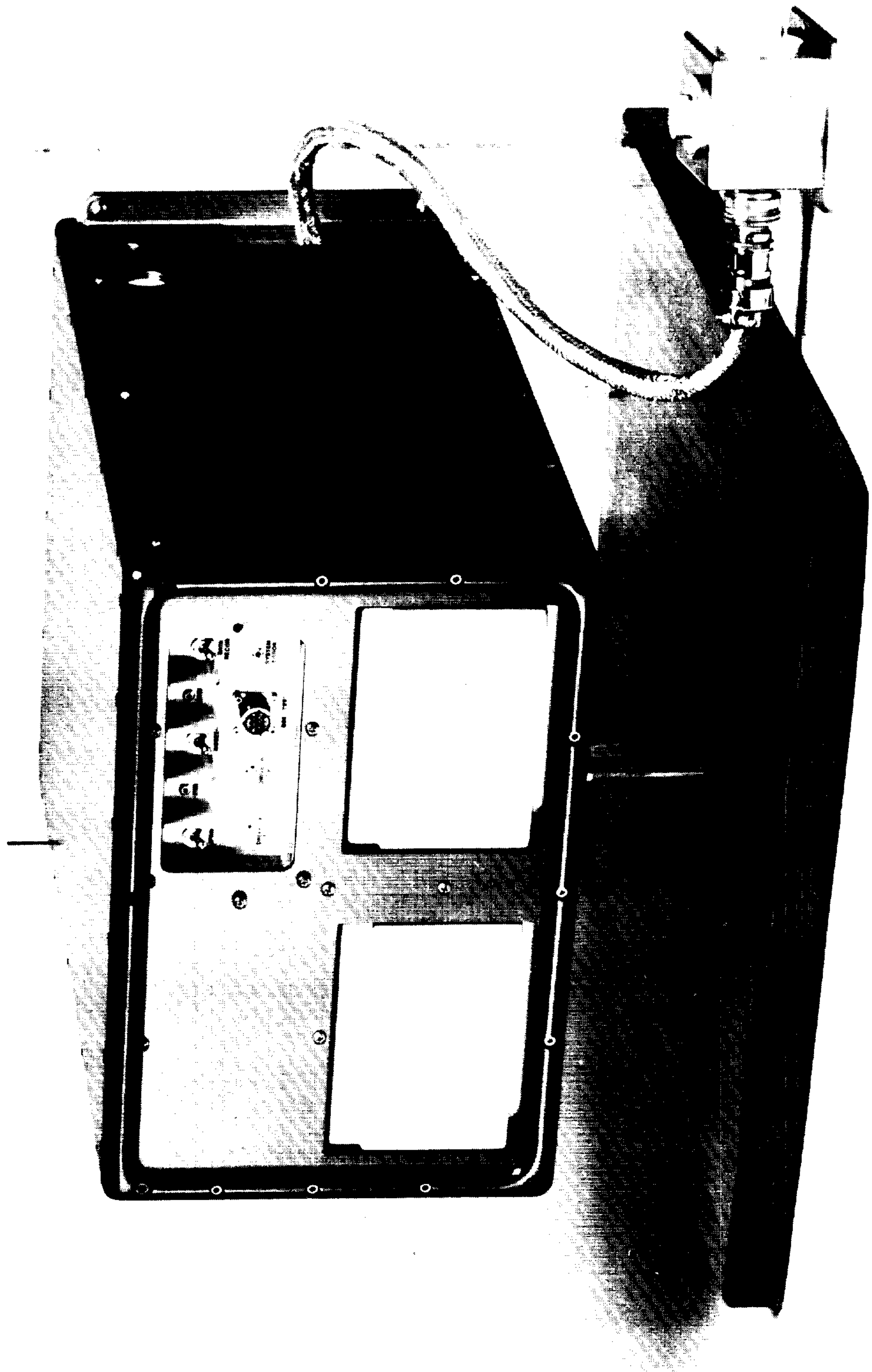

Figure 2. SAMS main unit with one triaxial sensor head.

APPENDIX

INTERNATIONAL MICROGRAVITY LABORATORY 1 CO-INVESTIGATORS AND GUEST INVESTIGATORS

Life Sciences

Gravitropic Responses of Plants in the Absence of a Complicating G-Force (6-IML-1)

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A Spaceflight Experiment to Investigate the Effects of a Range of Unilateral Blue Light Stimulations on the Movements of Wheat Coleoptiles (6-IML-1)

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D. Chapman
Gravitational Plant Physiology Laboratory
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Genetic and Molecular Dosimetry of HZE Radiation (7-IML-1

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University of San Francisco
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Chrondogenesis in Micromass Cultures of Embryonic Mouse Limb Mesenchymal Cells Exposed to Microgravity (7-IML-1)

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Microgravitational Effects on Chromosome Behavior (7-IML-1)

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East Carolina University School of Medicine
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Effects of Microgravity and Mechanical Stimulation on the In Vitro Mineralization and Resorbtion of Fetal Mouse Lone Bones (7-IML-1)

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The Role of Gravity in the Establishment of the Dorsoventral Axis in the Amphibian Embryo (7-IML-1)

Effect of the Space Environment on the Development of Drosophila Melanogaster (7-IML-1)

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M. Maroto
UAM Institute of Biomedical Investigations
Spain

The Effect of Microgravity Environment on Cell Wall Generation, Cell Division, Growth and Differentiation of Plants From Protoplasts (7-IML-1)

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Embryogenesis and Organogenesis of Carausius Morosus Under Spaceflight Conditions (7-IML-1)

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Dosimetric Mapping Inside Biorack (7-IML-1)

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Growth and Sporulation in Bacillus Subtilis Under Microgravity (7-IML-1)

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Friend Leukemia Virus Transformed Cells Exposed to Microgravity in the Presence of DMSO (7-IML-1)

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Proliferation and Performance of Hybridoma Cells in Microgravity (7-IML-1)

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Dynamic Cell Culture (7-IML-1)

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The Genotypic Control of Graviresponse, Cell Polarity and Morphological Development of Arabidopsis Thaliana in a Microgravity Environment (7-IML-1)

Transmission of Gravistimulus in the Statocyte of the Lentil Root (7-IML-1)

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Gravity Related Behavior of the Acellular Slime Mold Physarum Polycephalum (7-IML-1)

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Studies of Penetration of Antiobiotics in Bacterial Cells in Space Conditions (7-IML-1)

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Energy Expenditure in Space Flight (8-IML-1)

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Back Pain in Astronauts (8-IML-1)

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Measurement of Change in Venous Compliance in Microgravity and Evaluation of an Experimental Antigravity Suit (8-IML-1)

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Space Adaptation Syndrome Experiments (8-IML-1)

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Phase Partitioning Experiment (8-IML-1)

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Microgravity Vestibular Experiments (10-IML-1)

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Mental Workload and Performance Evaluation (15-IML-1)

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Radiation Monitoring Container/Dosimeter (16-IML-1)

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Microgravity Sciences

Study of Solution Crystal Growth in Low Gravity (2-IML-1)

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Studying the Influence of Gravity on Fluid Flow and Nucleation During Casting Through Directional Solidification of a Transparent Metal Model Under Microgravity Conditions (2-IML-1)

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Vapor Crystal Growth Studies of Single Mercuric Iodide Crystals (3-IML-1)

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Mercury Iodide Nucleation and Crystal Growth in Vapor Phase (4-IML-1)

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Protein Crystal Growth (5-IML-1)

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<u>Critical Point Facility (19-IML-1)</u>

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